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ISSUES IN LAND USE EVALUATION – AN ECONOMIC PERSPECTIVE ON AGRI-ENVIRONMENTAL POLICY

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RESUMO

O uso do solo é um fenômeno complexo, que ocupa um lugar proeminente na literatura econômica. Mais recentemente, o uso do solo alcançou uma posição central na discussão sobre sustentabilidade. A agricultura é uma das principais atividades econômicas responsáveis pelo uso extensivo do solo, e conseqüentemente o relacionamento triangular entre uso do solo, agricultura e desenvolvimento sustentável é freqüentemente abordado nas discussões sobre política ambiental moderna.

Este artigo oferece uma visão geral das questões econômicas envolvidas com a degradação da qualidade do ambiente e perda de biodiversidade decorrentes da transformação do uso do solo, diante dos desafios de uma política agro-ambiental sustentável. Procura-se destacar neste trabalho os elementos críticos na avaliação das mudanças no uso do solo com uma perspectiva econômica, com ênfase particular no papel exercido por autoridades públicas na criação de uma *framework* de escolhas públicas voltadas para o uso do solo e de recursos naturais.

Palavras-chave: uso do solo, sustentabilidade, política agro-ambiental.

ABSTRACT

Land use is a complex phenomenon and has gained a prominent place in the economic literature. More recently, land use has also acquired a central position in the sustainability discussion. Agriculture is one of the main economic activities that are responsible for extensive land use, and hence the triangular relationship land use, agriculture and sustainable development are very often addressed in modern environmental policy issues.

This paper offers an overview of economic questions involved with the degradation of environmental quality and biodiversity loss in relation to land use transformation, against the challenges of a sustainable agri-environmental policy. This publication aims to outline critical elements in the valuation of land use changes from an economic perspective, with particular emphasis on the role played by public authorities in creating a public choice framework in regard to natural resources and land use.

Keywords: land use, sustainability, agri-environmental policy.

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1. SETTING THE SCENE

Ever since the society of hunters and gatherers evolved into a society based on a sedentary lifestyle, agricultural systems have been the dominant sources of food supply for human beings. Although more than one factor has stimulated the development of agriculture, it is widely accepted that population growth is a principal driving force for societies to begin cultivating crop plants and domesticating wild animals. After all, agriculture has two major advantages over pre-agricultural systems. It increases the amount of food produced per unit of area, and it has the ability to artificially manipulate yields, which has become especially important since the invention of artificial fertiliser by Liebig in 1840 (CLEVELAND 1994, ANDREAE 1981, BIRNIE 1962).

The evolution and development of agriculture goes along with increasing urbanisation and civilisation, leading to the spatial organisation of large agricultural and rural areas versus concentrated urban areas. Prior to the Industrial Revolution in the second half of the nineteenth century, the two parts of the spatial system co-existed within a relationship of mutual dependence. The agricultural areas supplied food and fibre to the urban areas, the growth of which was, to a considerable extent, sustained by the processing, marketing and trading of those products. However, emerging industrialisation increased the demand for non-agricultural products, implying that urban growth lowers urban dependence on the supply of agriculturally produced goods. The relationship between agricultural and urban-industrial areas has changed into a one-sided dependency of the agricultural area on the urban core, a situation that is often referred to as heartland-hinterland relationship. The heartlands, with their high concentration of labour force in manufacturing, industry and the service sector and their high capacity to generate innovative changes, determine the types of resources and products the hinterlands (the rural and agricultural areas) need to supply. Development and growth of the hinterlands is thus dependent in all aspects on the activities of the heartlands (BERRY *et al.* 1976) and has drastic implications for land use.

Land use is indeed a complex economic phenomenon, as the demand for land has often a derived nature. Land is often an intermediate good which acts as a medium for economic forces. It may have both a productive and a consumptive character, while it offers a wide variety of functions which have a potential economic value (recreation, agriculture, site for dwellings or industries etc. (see amongst others BRAMLEY 1993, MUTH 1971, PRYCE 1971 and TOKUNAGA 1996). Consequently, land use has become a popular topic for valuation studies (e.g., contingent valuation studies, hedonic price studies). In a way, the history of economic thinking offers already several interesting illustrations of early interest in the value of land, as witnessed inter alia by the Physiocrats who claimed that the productive capacity of land (and nature) was the major source of welfare. Until the 1980s, land did in general not receive a specific interest from economists, as is reflected in the following quotation by Randall and Castle (1985, p. 573): “There seemed no reason to accord land any special treatment that would suggest its role is quite distinct from that of the other factors. Land could safely be subsumed under the broader aggregate of capital…”.

The increased interest in land as a scarce commodity in the past decades has been induced by the ‘new scarcity’ mirrored inter alia in land degradation and the ‘tragedy of the commons’. Land use at both a local and global seale has exhibited dramatic changes (e.g. deforestation, desertification, loss of biodiversity). In general, we observe a transition from natural areas into agricultural, urban or industrial land uses. The negative effects of excessive land use exploitation are manifold: soil erosion, loss of habitats, decrease in carrying capacity of land etc. The awareness of the great many negative externalities of land use transformations is rapidly growing (see VAN KOOTEN 1993). As a consequence, the spatial-environmental aspects of land use have received due attention, although an operational methodology for a mature, regional- economic and environmental-economic analysis of land use is still missing (cf. BARNETT and PAYNE 1995, BEINAT and NIJKAMP 1997, 2001, FINCO and NIJKAMP 1999, OSTROM 1990, OWENS and COWELL 2001, and PEZZEY 1989).

The World Bank Development Report (World Bank 1992) states in this context: “Degradation and destruction of environmental systems and natural resources are now assuming massive proportions in some developing countries, threatening continued, sustainable development. It is now generally recognised that economic development itself can be an important contributing factor to growing environmental problems in the absence of appropriate safeguards. A greatly improved understanding of the natural resource base and environment systems that support national economies is needed if patterns of development that are sustainable can be determined and recommended to governments”.

The sustainability issue has acquired a prominent position in the field of agricultural land use. Agriculture distinguishes itself from most other economic activities by employing land as a principal capital input

(REICHELDERFER and RANDALL 1993). In most countries in the developed world, the contribution of primary agriculture and the food processing industry to the Gross Domestic Product (GDP) is small. For both sectors, the average Gross Value Added as a percentage of GDP lies around two percent. Exceptions are Turkey, Greece and New Zealand, where primary agriculture contributes 14, 5.4 and 5.4 percent of the GDP, respectively (OECD 2001a). The Netherlands has a strong food processing industry, contributing ten percent of the GDP (LEI 2002).

Despite the generally limited importance of the agricultural sector to national accounts, agriculture occupies a large part of a nation's land resources. The following figure shows the development of agricultural land as a percentage of total land area between 1960 and 2000 for three selected regions (see Figure 1).

Figure 1: Agricultural land as a percentage of total land area for selected regions between 1960 and 2000 (Source: FAO 2002)

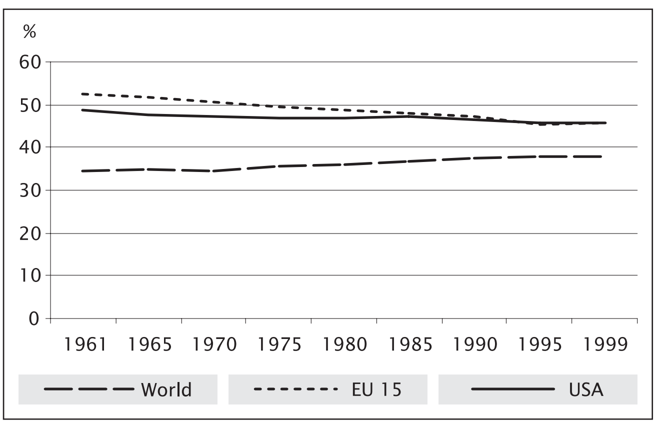

Figure 1 shows that, in the 1960s, the percentages of agricultural land in the EU 15[1] and the US have been far above that on a world level, with a converging trend emerging since the 1970s. Reasons for an increasing (decreasing) share of agricultural land on global (EU 15 and US) levels are the following. On a global level, massive land use conversions, mainly from natural ecosystems, such as forests and savannahs, to cultivated land and pastures have taken place during past decades. The main driving force behind land use conversions is the increasing requirement for food due to population growth, especially in the developing world (Fresco 1994). In the European Union and the US, agricultural productivity increases have resulted in self-sufficiency and even in substantial surpluses. In order to cut down on overproduction, agricultural land is being successively taken out of production and reallocated to nature (Rabbinge *et al.* 1994). Mainly marginal land in less fertile areas has been taken out of production. The landscapes of fertile regions have remained relatively unchanged, leading to a polarisation into regions of intensive agricultural production and regions of marginal production that may eventually face the abandonment of agricultural land (BALDOCK *et al.* 1996, REENBERG and BAUDRY 1999). Expanding urbanisation, industrialisation and infrastructure are another important reason for agricultural land's decreasing share in total land use (GARDNER 1977).

There is, however, a justification for why agriculture is the biggest land user in most developed countries. Agricultural land not only serves as a source for economic returns, but also preserves habitats and biodiversity, provides a carbon sink, and contributes to the conservation of water and soil resources (OECD 1998a). Both cultivated plant species and many weeds in cultivation might become extinct without the cycle of cultivation, harvesting and seed storage. Furthermore, crops and, in particular, their residues after harvesting form a valuable source of food for migratory birds (Steenblik *et al.* 1997). Along with these important functions for flora and fauna, agricultural land also contributes to the preservation of open space and the maintenance of characteristic landscape elements; these aspects are largely responsible for the recreational value of agricultural land. The agricultural and environmental economics literature includes many studies on the (recreational) value of agricultural land, applying monetary valuation methods, such as contingent valuation or travel cost approaches (e.g., BROUWER and SLANGEN 1998, BRUNSTAD *et al.* 1999, DRAKE 1992, FLEISCHER and TSUR 2000, FURUSETH 1987, HANLEY *et al.* 1998, KLINE and WICHELNS 1996, PRUCKNER 1995, WILLIS and GARROD 1993).

In the framework of the global concern on degradation of environmental quality and biodiversity loss in relation to land use transformation, the concepts of sustainable development has increasingly gained popularity in scientific and policy circles. The present note serves to outline some critical elements in the valuation of land use changes from an economic perspective, with particular emphasis on the role played by public authorities in creating a public choice framework in regard to natural resources and land use. The paper is organised as follows. In the next section we pay attention to the relationship between land use and policy-making from a sustainability

[1] The EU 15 includes Finland, Sweden, Denmark, Germany, the Netherlands, Great Britain, Ireland, Belgium, Luxembourg, France, Austria, Spain, Portugal, Italy and Greece. In the text, EU 15 refers to these countries alone. "European Union" refers to the EU in general, regardless of differences in membership over time.

perspective. Then we offer an economic valuation perspective on land use, followed by an analysis of sustainable land use policies. Finally, we offer some conclusions.

2. LAND USE PLANNING AS A POLICY CHALLENGE

The sustainability debate has prompted various debates on the sustainability of land use. There has been an avalanche of publications in the past decade on sustainable land use. We refer here to Bryden (1994) who distinguishes three major dimensions which characterize sustainable land use:

1. The *husbrandy* dimension, which relates to the durability, exploitability and continuity of natural resources over a long time horizon. The use of crop-rotating systems, the careful use of scarce natural resources and the rehabilitation of degraded land can be seen as actions oriented towards the husbrandy dimension. Keeping the amount and quality of the natural resources stock is at the core of this dimension.
2. The *interdependence* dimension, which focuses on aspects like fragmentation, segmentation and relations between different types of land use. Traditional farming offers examples of interdependence, in which the farm and the surrounding natural areas achieve an equilibrium based on interaction and mutual system resilience. Maintaining the type and quality of the natural-human system interactions is at the basis of the interdependence dimension.
3. The *ethics dimension*, which refers in particular to obligations towards future generations. Concepts like option value, existence values and the like can be interpreted in terms of the ethics dimension.

Land use changes have a particular feature as a derived economic force. Human activities such as production, consumption, investment or recreation need geographical space for their fulfilment. Apart from the role as a capital asset, space does usually not have an intrinsic value; it serves to meet the demand for other economic activities. Conflicts in land use are normally originating from conflicts around alternative functional demands on scarce space.

Land-use planning has been traditionally concerned with the solution of a fundamental trade-off: conservation versus economic exploitation. Conservation refers to the preservation of the natural resources stock (e.g. water, soil, air) or the biological stock (e.g. the conservation of the genetic pool), but also the recreation of lost land (e.g. reforestation of fallow land) and the rehabilitation of degraded land (e.g. cleaning-up contaminated sites). The relationship between conservation and sustainability is rather straightforward. Conservation involves the prevention of disruptive developments and the retracing of past developments in order to keep the environmental stock available for future generations. The economic dimension of land use management, in contrast, refers to the relationship between sustainability and a durable socio-economic system.

Policies on sustainable development and land-use planning have increasingly moved from a global level to a meso approach (area level or a sector intervention). The introduction of the spatial dimension has also permitted the development of additional sustainability management concepts, such as strong and weak sustainability (see van PELT 1993, PEARCE and TURNER 1990). Strong environmental sustainability would imply that in all areas an improvement of environmental quality conditions would take place. Weak sustainability refers to a situation where in some areas an environmental degradation has to be accepted, provided this is at least compensated for by improvements elsewhere. The substitution possibilities may be further widened if the concept of environmental sustainability is extended towards the broader concepts of sustainable development (which includes the economic and social dimensions besides the environmental dimension). Trade-offs between environmental, economic and social conditions may then be considered.

Every economic activity on production as well as on consumption side requires land resources. Agriculture, industry and services all need a location for their firms and additionally, most of the production inputs stem from some kind of land use. Consumers demand land resources for housing, recreation and infrastructure. Furthermore, both economic groups use land as a sink for production and consumption waste. Regarding all these evidences it can be stated that land is the most basic and essential resource for economic activity and that land use is one of the most important issues in the ongoing discussion about sustainable economic development. As Beinat and Nijkamp (1997) mentioned: *"Land use is at the heart of the sustainability debate".*

Despite its beneficial functions, intensive agricultural land use generates harmful environmental effects. The most prominent examples of these effects are ground and surface water pollution due to the run-off of artificial fertiliser, livestock manure and pesticides, soil erosion, the degradation of habitats, biodiversity and landscape due to upscaling and production specialisation, and the emission of nitrous oxide, a greenhouse gas contributing to climate change (OECD 1998a). Table 1 gives an overview of important environmental impacts from different agricultural practices. The environmental impacts are categorised into four different environmental media: air, water, soil, and nature, wildlife and landscape.

Describing the full range of environmental impacts mentioned in Table 1 in detail would go beyond the scope of this paper. For example, euthrophication and acidification resulting from over-fertilisation and manure surpluses are the most relevant impacts from agricultural practices on the environment in the Netherlands. The amount of money spent on measures against eutrophication and acidification from Dutch agriculture rose from 43 million Euro in 1990 to around 95 million Euro in 2000 (RIVM 2001).[2]

Agricultural land use decision-making can either be made along the intensive or the extensive margin. Changes at the intensive margin occur through increasing production per unit of land, either by means of increasing input use or by changing to higher-valued crops. Changes at the extensive margin occur through taking formerly unused land into production (Van KOOTEN 1993). The decreasing shares of agricultural land in the US and the EU 15, which were shown in Figure 1, in combination with the increasing production values realised in these regions during the past decades, lead to the conclusion that production increases have been realised at the intensive margin, i.e., through increasing production per unit of land. Alston *et al.* (,1995) find an average annual growth rate of land productivity (measured as output per unit of land) of 1.6 across OECD countries between 1961 and 1990. The growth rates range from a negative rate of -0.10 in Japan to a very high positive rate of 3.14 in the Netherlands. In comparison, labour productivity (measures as output per unit of labour) exhibits an even higher growth rate over the same period. The average annual growth rate across OECD countries is 4.0, ranging from 1.35 in New Zealand to 6.01 in Belgium-Luxembourg.

The multifunctional nature of land and the wide diversity of environmental externalities involved with land use transformations makes the development of an unambiguous evaluation system problematic. This will be further discussed in the next section.

Table 1: Overview of important environmental effects from different agricultural practices

Environmental media Agricultural practice		Air	Water	Soil	Nature, wildlife and landscape
Specialisation and concentration	Increasing field size, removal of vegetation cover and land consolidation		• removal of vegetation cover → increased surface runoff → sedimentation, eutrophication →	• removal of vegetation cover → soil erosion • inadequate management → soil degradation	• loss of hedgerows, woodlands and small watercourses → decrease in landscape variety and species reduction
	Intensive animal husbandry	• emissions of methane and ammonia	• silage effluent → organic matter and nutrients in water bodies	• spreading of manure high in heavy metal content → elevation of soil concentration	• construction of storage silos → changed landscape
	Intensive cropping		• soil erosion → increased sediment runoff → water pollution	• loss of organic matter in soil → decline in soil fertility and absorption capacity → increased erosion and runoff	• changed landscape through increasing field size and land consolidation

[2] These costs include capital and operating costs on an annual basis for measures that have a positive effect on the environment. They include expenses made by private persons and public authorities.

Table 1 (cont.): Overview of important environmental effects from different agricultural practices

Environmental media Agricultural practice		Air	Water	Soil	Nature, wildlife and landscape
Fertilisation	Animal manure	• ammonia and nitrous oxide volatilisation • unpleasant odours	• spills of organic matter and nutrients to water bodies → eutrophication → oxygen depletion → excess algae and water plants, fewer fish • leaching to groundwater → pollution of drinking water supply	• accumulation of heavy metals and phosphates in soil → may enter the food chain • overapplication → soil acidification	• potential loss of nutrient poor habitats
	Mineral fertiliser	• ammonia and nitrous oxide release	• nitrate leaching and phosphate runoff → elevated nutrient levels → eutrophication of fresh and coastal coastal waters, contamination of aquifers	• overapplication → local acidification → deterioration of soil structure, imbalance in nutrients	
Pesticides application		• evaporation and pesticide drift → adverse effects in nearby ecosystems	• leaching of residues and degradation products → impacts on fish and other water animals and on drinking water resources	• accumulation of persistent pesticides • use of broad spectrum pesticides → impacts on soil microflora, may affect or eradicate non-target organisms	• possible wildlife poisoning incidents in non-target organisms • loss of habitat and food source for non-target species • resistance on some target organisms
Irrigation and water abstraction		• lowering of the groundwater table → soil salinisation and alkalinisation → impacts of surface and groundwater quality → drinking water • high abstraction required for some crops → strain on resources in some areas	• waterlogging → salinisation and alkalinisation of soils • use of saline of brackish waters for irrigation in hot climates → increased salt precipitation and carbonates	• soil salinisation and alkalinisation → desertification and losses of species • drying out of natural elements affecting river ecosystems	

Table 1 (cont.): Overview of important environmental effects from different agricultural practices

Environmental media Agricultural practice		Air	Water	Soil	Nature, wildlife and landscape
Drainage		• chemical changes in soil → greenhouse gas emission	• lowering of the groundwater table	• oxidation of organic soils → acidification and changes in soil structure	• loss of wetlands and changes in botanical composition of grassland, fens and other habitats
Mechanisation	Tillage, ploughing	• increase in dust and particulate matter in air	• increased surface water runoff →sedimentation, eutrophication	• ploughing up and down slopes → soil erosion	
	Use of heavy machinery	• increased CO2-emission	• chemical changes in soil → greenhouse gas emission	• compaction and erosion of top soil	

(Source: EEA 1995)

3. AN ECONOMIC PERSPECTIVE ON SCARCE LAND

The overall involvement of land in economic activities indicates its multi-attribute nature and multifunctional character. This in turn leads to a strong competition among different economic actors with competing interests for land resources. However, land is not only essential for economic activity but also, and that is even more important, for the functioning of the ecological network and hence for maintaining the provision of environmental goods and services. According to Finco and Nijkamp (1997) space and land use can be seen as the physical market for environmental externalities, which means that all production and consumption externalities (positive as well as negative) show their effects trough the medium of land in one way or an other. Some examples of negative externalities are the contamination of soil and ground and surface water through, for instance, industrial sites, over-fertilisation in agriculture and rubbish-dumps and noise annoyance from different kinds of traffic or industrial factories. Some examples of positive externalities are the land value increase of building-sites adjoining newly constructed infrastructure or the recreational value provided by the countryside protecting activities of farmers.

The presence of especially negative externalities indicates that the allocation of present land use patterns is far from optimal. Natural resources and environmental amenities are in most cases in an inferior position, if it comes to the decision of the most profitable pattern of land use where negative effects of this land use patterns are not taken into account. Degradation and loss of biodiversity are the logical consequences of such kind of land use practices. In an optimal and efficient allocation of land use where the social welfare function is maximised, all externalities should be internalised and marginal utilities of the different kinds of land use should be equalised. The internalisation of externalities can take place with the help of particular environmental policy measures making use of economic instruments. There are different kinds of economic instruments in environmental policy-making that have been used and tested all over the world in recent years.

For example, Mahé and Ortalo-Magné (1999) explain why land prices play an important role in the evolution of the agricultural sector. Agricultural land capitalises the expected discounted returns from agricultural production that are left after all other production factors have been rewarded. Guaranteed prices, as they have been provided by the CAP (Common Agricultural Policy), lead hence to rather predictable (and relatively too high) future benefits. As a consequence, agricultural land under the CAP regime is being overvalued. Furthermore, a stock-taking of the CAP in 1992 showed that 20% of the farmers received 80% of the support. This uneven distribution indicates that the CAP is particularly beneficial for large farmers, whose investments capacity have increased more than proportional. The authors mention additionally that there is hardly any external capital in farming because of the low liquidity of land investments and low returns. The overvaluation of agricultural land and the lack of external capital is surely an entry barrier for potential new farmers. The possible evolution to a different kind of agriculture with "new" farmers willing to invest in environmentally sound production methods is therefore hampered.

The economic literature has generated a broad set of theoretical frameworks explaining the value (or rent) of land. These frameworks may be based on alternative use values, comparative analysis of the execution of different economic functions, the decided value of land as a result of the production of goods, the competition with urban or infrastructural uses, or the institutional value fixation by public authorities (cf. JUST and MIRANOWSKI 1993, and WEERSINK *et al.* 1999). In particular, the abatement of negative environmental externalities has prompted many debates among economists.

In the course of the history of environmental policy making starting in the late 1950s different economic instruments evolved. Roughly speaking, the time-path of environmental policies goes from authoritarian measures such as command and control via market-based instruments such as taxes, subsidies or tradable rights to co-operative instruments evolving lately where the 'perpetrator and victim' negotiate about compensation payments under an administrative supervision. Certainly, there are pros and cons to all of these instruments and the prevailing circumstances in the respective situations are of major importance for the performance of a particular instrument. Investigating the effects of environmental policy making on land use decision-making needs an elaborate overview of all relevant policy measures introduced in the particular situation and not only of that directly aiming at land use. Bateman (1988) emphasised that land use changes are generally a by-product of policies designed to meet other objectives and that these indirect policies are even more important to land use decision-making than the direct ones. This opinion agrees with the statement made in the introduction that every economic activity is related to some form of land use which implies that every economic policy measures will show its effect on land use changes.

Next to the question of the most efficient policy instrument there is the issue of the most efficient policy level at which environmental policy instruments are applied (VERBRUGGEN and KUIK 1997). Environmental policies can be applied at regional, national, international, European or supranational levels depending on the spatial scale of the environmental problem under consideration. Tinbergen (1954) defined the optimal policy level as that level where no externalities occur anymore beyond this level. The same idea is captured in the subsidiarity principle of the European Community, which says that the scope for EC policy is limited to those cases in which policy objectives can be better attained at an EC level rather than at a national or regional level. In an optimal situation the policies at the different policy levels are compatible with each other and do preferably support and reinforce each other (VERBRUGGEN 1994). In order to analyse the effects of environmental policy on land use changes it is hence necessary to investigate all policies at all different levels that are related to the problem at hand and to clarify the interactions and interrelationships among them.

An important issue in talking about environmental policies is the distribution of costs and benefits of a particular policy measure. In the case of environmental policies it is often observed that costs are concentrated on one or only a few parties, whereas benefits are mainly dispersed over a large part of the population. The concentration of costs to one or only a few parties implies the risk that these parties try to put pressure on political decision-making, which means that policy choices that are efficient and social welfare increasing from an theoretical point of view are not implemented. This prompts the need to resort to public choice theory that does certainly has to be considered in analysing environmental policies.

All models for measuring the impact of different policy alternatives need parameters and values that reflect the interrelationships and interactions within the environmental-economic system. At this point meta-analysis is the summary of effect sizes for a set of studies in order to obtain the "true" effect size (VAN DEN BERGH *et al.* 1997). This "true" effect size can subsequently be used as a parameter value in the sustainability analysis.

Another objective of meta-analysis is the determination of the factors that are responsible for variations in the effect sizes of similar studies. The impact of these variations can be measured with the help of so-called moderator variables. This application of meta-analysis could point out and underpin in an scientifically sound way that there are indeed differences among region that are decisive for the effects of alternative policy measures. This in turn would support the idea that policy-making at lower administrative levels where regional characteristics are considered more seriously will lead to more effective and efficient outcomes.

4. POLICIES FOR SUSTAINABLE LAND USE

Policy-making is a complex, interactive and continuously ongoing process. It is complex because many different agencies on various levels of government introduce policies that either directly or indirectly influence each particular policy issue. It is interactive because different policy options need to be negotiated, leading to trade-offs and compromises that open up new opportunities not initially considered. It is a continuously ongoing process since the implementation of one policy almost always generates new problems for the policy agenda (LINDBLOM and WOODHOUSE 1993).

Along with ensuring national self-sufficiency in food products, traditional supportive agricultural policy is meant to tackle another problem intrinsic to the agricultural sector, the chronic farm income problem. On the demand side, the income inelastic nature of food demand causes the agricultural sector's growth rate to lag behind the economic growth rates of other sectors in the economy. Consequently, farm income will rise less than income in other sectors. On the supply side, the temporal lag between price signals influencing production decisions and output response is rather large. Original market conditions may have changed, which may lead to exaggerated volatility in market prices. Accordingly, farm income is variable and unstable (KAY 1998). Additionally, rises in agricultural productivity brought about by technical innovations have led to decreasing food prices.[3] Policy instruments, such as price support and price stabilisation, are applied to overcome the chronic farm income problem. Agricultural policy has hence solved one group's problem, that of the farmers. However, because of its well-known adverse external effect on the environment, this solution turned out to create welfare losses for another group, the environmentalists.

The decreasing importance of the agricultural sector and changing consumer preferences, as reported in earlier chapters of this dissertation, have shifted the emphasis of agricultural policies in many industrialised countries. Although the viability of the agricultural and rural community is still an important objective for the reformed policies, nature conservation and the protection of environmental amenities receive considerably more attention than they did before the reforms. Overall, as for many other fields of policy, the guiding principle for agricultural policy should be sustainable development and sustainable agricultural land use.

According to the World Commission for Environment and Development (WCED 1987), sustainable development requires the integration of environmental objectives with more general financial, economic and industrial policies. It is supposed that this integration helps to overcome the failure of environmental policies as it was experienced in many developed countries when environmental policy making was first initiated. The policy failure has become visible in the gap between the environmental policy objectives that were aspired to, on the one hand, and the actual realisation of these objectives, on the other hand. Verbruggen (1994) argues that policy failure is mainly due to an instrument crisis, caused by a) inefficient and ineffective application of environmental policy instruments, b) failure to apply environmental policy instruments at the optimal level of government (the local, regional, national or international level) and c) inconsistent policy-making and insufficient coordination between different levels of government and different sectors in the economy. The causes for the instrument crises are, in fact, institutional failures. A proper institutional framework is hence a necessary condition for the application of policy instruments.

Cause c) becomes especially apparent in the agricultural sector. Agricultural and environmental policies affecting agricultural land use are often contradictory. Examples of such contradictions include set-asides of productive farmland in order to reduce commodity surpluses on the one hand and subsidising irrigation water to increase productivity on the other hand. Likewise, subsidising farmers who adopt soil conservation practices while supporting prices of highly erosive crops seems incongruent (REICHELDERFER and RANDALL 1993). Furthermore, the agri-environmental policy of the European Union (Regulation 2078/92) seems to be poorly integrated with other Common Agricultural Policies (CAP). Among others, this becomes obvious in observing the regular CAP programme's maize premium, which is in many cases higher than the grassland premium under the agri-environmental policy (BULLER 2000).

For agricultural sustainability in particular, numerous definitions can be found in the literature (for an overview, see HANSEN 1996). Ikerd (cited by RIGBY and CÁCERES 2001) gives an understandable definition: Sustainable agriculture is "... capable of maintaining its productivity and usefulness to society

[3] In a study on technical progress and structural change in agriculture in OECD countries, Alston *et al.* (1995) point out that the prices farmers receive for their products have been falling, not only in real terms, but also relative to the prices farmers pay for their inputs.

over the long run...it must be environmentally sound, resource-conserving, economically viable, commercially competitive and socially supportive". Obviously, this definition includes the three dimensions noted above.

Conventional agricultural production is often associated with the depletion of non-renewable resources, soil degradation, negative health and environmental effects from agricultural chemicals, inequity, declining rural communities, loss of food quality and a decrease in the number of farms, along with an increase in their size. It is therefore often perceived as unsustainable (HANSEN 1996). Sustainable agriculture is often regarded as an alternative to conventional agriculture and its characteristics are mainly described as the opposite of those of conventional agriculture (BEUS and DUNLAP 1990, HILL and MACRAE 1988).

However, Hansen (1996) warns that stigmatising conventional agriculture for being unsustainable and alternative agriculture[4] for being sustainable may lead to a distorted view of conventional agriculture. For example, Trewavas (2001) points out that *integrated farm management*, a conventional farming strategy for retaining the benefits of modern agricultural technology while minimising the environmental problems, may lead to an equal reduction of environmental pressure as that which organic farming produces. In such a case, approaches that enhance sustainability may be ignored or rejected because of their association with conventional agricultural methods. Furthermore, alternative agriculture often puts more emphasis on the ecological dimension of sustainable development. It is often criticised for neglecting the social dimension, i.e., meeting the needs of growing populations, an issue especially important in developing countries.

The relative weights of the three dimensions of sustainability in policy-making also differ over time. Current levels of agricultural support in most developed countries are said to be unsustainable, especially with respect to the macro-economic and ecological dimensions. Expenses for agricultural support measures put an increasing financial burden on the public budget. A good example is the European Union and its prospective expansion to the East. An enlargement of the EU would not allow the continuation of the same level of agricultural support as is employed in the current Member States. In other words, the financial expenses cannot be 'sustained'. With respect to the ecological dimension, agricultural support levels are supposed to stimulate farming practices that put increasing pressure on the environment and that are to a large extent dependent on non-renewable and off-farm resources. A continuation of these farming practices is said to be unsustainable. However, these policies mainly evolved after the Second World War, when security of the food supply was the most important objective on the policy agenda. In those days, ecological considerations may not have been considered important and may not have been accepted by societies that had experienced periods of famine during the last years of the Second World War.

Having discussed the issues of sustainable development and agricultural sustainability, we recognise that the two terms cannot be properly described within a single definition. In response, the literature on sustainable development has come up with the idea of sustainability indicators (PANNELL and GLENN 2000). Sustainability indicators measure and evaluate a certain policy option for its suitability in creating sustainable development (PEARCE 1999). They are described in further detail hereafter.

Although in the context of this paper we are mainly interested in measuring agricultural sustainability, we will first look at some general issues of sustainability measurement. An important factor that needs to be considered is the concept of weak versus strong sustainability. The main difference between weak and strong sustainability lies in the assumption that different types of capital may be considered substitutes. The literature distinguishes between four types of capital (TISDELL 1997, SERAGELDIN 1996, PERMAN *et al.* 1996):

a) *Natural capital*: the naturally provided stock of assets, such as water systems, soil, atmosphere, wetlands, crude oil and gas, minerals, forests, fish and other stocks of biomass.

b) *Physical capital*: capital that is usually considered in economic accounts, such as machines, plants, buildings and infrastructure.

c) *Human capital*: the stock of knowledge and learned skills embodied in particular individuals.

d) *Social capital*: institutional and cultural basis for the functioning of society; the stock of knowledge that is not embodied in particular individuals.

[4] Alternative agriculture comprises several alternative approaches, such as organic farming, regenerative agriculture, ecological agriculture, biodynamic agriculture, permaculture, natural farming and low-input agriculture (Beus and Dunlap 1990).

The combination of physical, human and social capital may be described as man-made capital. Weak sustainability assumes that there are substitution possibilities between all four types of capital. As long as the total amount of capital is kept constant, weak sustainability is attained, regardless of the composition of total capital. Strong sustainability requires that natural capital remain constant (SERAGELDIN 1996). Weak sustainability is criticised for not taking into account essential life-supporting functions of the ecosystem (PEARCE and ATKINSON 1995). It does not consider the fact that in most production processes, natural and man-made capital (physical capital in particular) are complements. Strong sustainability implies that the use of non-renewable natural resources has to be ceased and that only the net annual growth rates of renewable natural resources may be used. 'Pure' weak or strong sustainability is therefore considered unrealistic. An appropriate interpretation of sustainability would lie somewhere in between the two extremes (TISDELL 1997, SERAGELDIN 1996).

Effective tools for the operationalisation of sustainability development are sustainability indicators. From a macro-economic perspective, measuring sustainable development would be equivalent to measuring non-declining well-being over time, given an ideal composition of total capital. Indicators for this purpose have been proposed in the literature on environmental or 'green' national accounting (e.g., ATKINSON *et al.* 1997, ARONSSON 1997, PERMAN *et al.* 1996).

Let us now turn to the discussion of agricultural sustainability indicators. A complete agricultural sustainability indicator would need to include the ecological and economic dimension, as well as the social dimension. However, Rigby and Cáceres (2001) point out that the construction of a single indicator combining information from all three dimensions is very difficult. Units and appropriate scales of measurement both differ within and across identified ecological, economic and social dimensions. Therefore, the construction of indicators always requires a trade-off between the extent to which the indicator captures necessary information and the ease of measuring and monitoring. Hansen (1996) suggests interpreting sustainable development in agriculture as a set of strategies that respond to the problems emphasised and that consider ideas of commonly accepted improvements. For example, a set of strategies may contain strategies for changing farming practices, such as the reduction of livestock density, which correspond to the problem of organic fertiliser surpluses. A commonly accepted aim is to reduce nitrate pollution generated by intensive agricultural livestock farming. A strategy of 'reduction of livestock density' may solve this commonly accepted problem. This example illustrates that specific strategies are more tangible and less vague than the term 'sustainability' and may facilitate the construction of proper indicators.

Agricultural sustainability indicators need to consider three basic aspects: 1) the magnitude of the agricultural sector, 2) the composition of agricultural output, and 3) the way in which output is produced. Responding to these three aspects demands an understanding of agricultural activities within the environment (PEARCE 1999).

The OECD (1999) has defined three major functions of environmental indicators in agriculture. Firstly, they should provide information to policy makers and the general public about the state of the environment as influenced by agriculture. Secondly, they should help policy makers better understand the cause-effect linkages between agricultural activity and the environment. Thirdly, they should assist in the evaluation of the effectiveness of agricultural and environmental policy instruments. In order to comply with these three demands, the OECD has proposed the Driving Force-State-Response (DSR) framework (OECD 1999). Driving forces are the factors that cause environmental quality change. Agricultural land use intensity, natural processes and climatic conditions, but also economic and social factors, such as market signals, government policy and cultural aspects influencing agricultural land use, belong to the category of driving forces. The state-indicator describes the actual condition of the environment, e.g., the nutrient level in ground and surface water or the number of protected species in a certain area. Responses refer to the reactions of policy makers and groups in society to the state of the environment. A particular policy that may be a response would then again change the driving forces, which, in turn, influences the state of the environment. In fact, the state-phase in the DRS framework may be regarded as the most appropriate indicator for policy evaluation, since it gives direct information about the effects of a particular policy measure on environmental quality. However, especially in agriculture, it is also the most difficult one to assess. An important reason for this is the time and space dimension inherent in the cause-effect relationship between agricultural production and the state of the environment. The time and space dimension implies that the effects of agricultural pollution may become visible only after a number of years, or that the effects of agricultural production are spread over long distances through, for example, water or air. Another significant reason for this effect is that the assessment of state indicators is, in most cases, rather costly (DEBLITZ 1999).

Verbruggen (1994), citing Tinbergen, points out that the optimal government level to be responsible for a particular problem is the level beyond which no externalities occur. This idea is also captured in the subsidiarity principle, which the European Commission established in the Single European Act in 1986. The subsidiarity principle assigns decision-making and the enforcement of environmental policies to the lowest level of government capable of handling them without significant residual externalities (TURNER and OPSCHOOR 1994). The optimal government level to deal with a particular environmental issue therefore depends on the spatial scale of the respective environmental good or bad. Verbruggen and Jansen, (1995) distinguish between four different dimensions that characterise the spatial scale of an environmental externality, which should determine the optimal government level for policy negotiations:

1) the geographical extent of an environmental good or system (e.g., river, lake, forest or wetland),
2) the pattern of transport of pollutants (air, water, soil; short or long distance),
3) the pattern of trade flows in cases where traded products are media of environmental effects,
4) psychological spillover effects when the degradation of ecosystems or treatment of animals in one country affects the psychological well-being of other people in other countries.

Agricultural and environmental policy instruments can generally be divided into three main categories: 1) direct regulation or command-and-control instruments, 2) economic or market-based instruments and 3) communicative or persuasive instruments (VERBRUGGEN 1994). Table 2 shows some examples of the three types of policy instruments affecting agricultural land use.

The most basic policy regulating agricultural land use is public land use planning, which falls under direct regulations. Public land use planning, such as zoning or spatial planning, which is especially important in European countries, determines where agricultural production may take place.

Table 2: Examples of three types of policy instruments

Direct regulation	Communicative instruments	Economic instruments
• public land use planning (zoning/spatial planning) • pollution standards • prohibition of particular agro-chemicals and agricultural production methods	• agricultural extension service • public education and persuasion • co-operative approaches	• taxes • subsidies • price support • import/export tariffs • tradable rights and quotas

However, although progress has been made in the estimation of non-market values, the precise determination of environmental costs and benefits is still problematic, so that the imposition of taxes and subsidies to correct for the externality problem does not necessarily result in a first-best solution. Another issue concerning the information requirement deals with the fact that the cost and/or benefit functions of all firms need to be identical if an overall uniform tax and/or subsidy would be applied. Especially in the agricultural sector, where there are many firms with different production and management structures, uniform cost and/or benefit functions are very unlikely. Zilberman and Marra (1993), referring to Baumol and Oates, mention that a second-best solution has to be applied if a first-best solution is not feasible. Their second-best solution implies that the policy maker determines some aggregated environmental target and that the least-cost policy may be implemented to reach the target. The second-best solution may be a tax or a subsidy; it does not, however, result in a Pareto-optimal allocation of resources.

In a discussion of subsidies as a policy instrument for resolving the externality problem, a number of important aspects must be mentioned. A subsidy to reward the production of positive externalities may, under the mentioned condition, indeed result in a Pareto-optimal resource allocation. However, a considerable number of subsidies are granted to pollution abatement, which implies the reduction of negative externalities. Stiglitz (1986) emphasises that subsidising pollution abatement does not result in socially-efficient resource allocation. The total marginal social costs of private production include, along with the external costs arising from the pollution from private production, the costs of government subsidies for abatement. Polluting firms do not take these additional social costs into account. The social marginal cost curve thus continues to exceed the private marginal cost curve, which implies that the level of production is still too high. Furthermore, Baumol and Oates (1975) mention that the uncontrolled granting of subsidies may attract new firms into a business or may keep inefficient firms in the business, which may off-set the pollution reduction attained by a single firm. Granting subsidies for pollution control may not be regarded as unfavourable in general. It must be noted, however, that the previously discussed issues concerned with the use of subsidies for pollution abatement need to be taken into account in the policy-making process.

5. CONCLUSIONS

Policy-making is a continuously ongoing process and new policy issues may be generated through the implementation of previously-defined policy options. The objectives of policies regarding particular sectors or particular groups in an economy normally change over time, reflecting changing social preferences. The current policy objective in almost all fields of policy is sustainable development. Sustainable development is a very broad term and it remains difficult to choose between actual policy options for attaining sustainable development. The most fundamental difficulty with this objective is the fact that whether or not a particular policy option has turned out to be sustainable may only be determined *posteriori*.

Sustainable development needs to take place along three dimensions, namely, the ecological, economic and social dimensions. The current discussion on sustainable development is very often biased towards the ecological dimension. With regard to the environmental issues, it is often stated that the supportive agricultural policies introduced in the first half of the twentieth century are unsustainable since they lead to the exhaustion and pollution of soil and water resources. It is, however, very unlikely that agricultural policy-makers after the Second World War would have taken the ecological dimension into account, which would imply that they deliberately risked the ecological value of agriculturally-related environmental resources. Would it not be much more likely that former agricultural policy-makers considered the economic and social dimensions of the agricultural sector unsustainable? The post-war period was marked by food shortages and public preferences presumably were for sufficient food supply rather than for the ecological value of environmental resources, in order to *sustain* human nutritional requirements. Returning to the current situation, it is certainly true that extensive agricultural production methods relieve the pressure on the environment and may follow the track of ecological sustainable development. It is, however, questionable whether they are also able to meet the nutritional needs of a growing world population, which would imply unsustainable development along the social dimension.

It becomes obvious that a certain policy that is regarded as the correct option at a certain point in time may not be appropriate at another point in time. Regarding the agricultural sector in western, industrialised countries, we are currently at a point in time at which the ecological dimension of sustainable development receives the most attention. Ecologically sustainable development may be measured with the help of indicators that aim at measuring the effects of particular agricultural practices on the environment. Tangible indicators are needed in order to use the 'fuzzy' concept of sustainable development for practical policy-making. The policy-making process may result in the application of different types of policy instruments, such as taxes, subsidies or co-operative approaches, which are supposed to encourage more efficient use of environmental resources and which are ultimately meant to encourage sustainable agricultural development.

REFERÊNCIAS BIBLIOGRÁFICAS

ANDREAE, B. **Farming development and space**. Berlin: Walter de Gruyter, 1981.

ARONSSON, T. **Welfare measurement, sustainability and green national accounting:** a growth theoretical approach. Cheltenham: Edward Elgar, 1997.

ATKINSON, G.; DUBORG, R.; HAMILTON, K.; MUNASINGHE, M; PEARCE, D. W. **Measuring sustainable development: macroeconomics and the environment** Cheltenham: Edward Elgar, 1997.

BALDOCK, D.; BEAUFOY, G.; BROUWER, F.; GODESCHALK, F. **Farming at the margins**. London: Institute for European Environmental Policy, 1996.

BARNETT, V.; PAYNE, R. (Eds.). **Agricultural sustainability**. New York: John Wiley, 1995.

BATEMAN, D. The impact of public policies on rural land-use. In: WHITBY, M. C.; OLLERENSHAW, J. (Eds.). **Land use and the european environment**. London: Belhaven Press, 1988. p. 90-101.

BAUMOL, W. J.; OATES, W. E. **The theory of environmental policy**. Cambridge: Cambridge University Press, 1975.

BERGH, J. C. J. M. van den; BUTTON, K. J.; NIJKAMP, P.; PEPPING, G. C. **Meta-analysis in environmental economics.** Dordrecht: Kluwer, 1997.

BERRY, B. J. L.; CONKLING, E. C.; RAY, D. M. **The geography of economic systems**. Englewood Cliffs: Prentice-Hall, 1976.

BEUS, C. E.; DUNLAP, R. E. Conventional versus alternative agriculture: the paradigmatic roots of the debate. **Rural Sociology**, v. 55, n. 4, p. 590-616, 1990.

BIRNIE, A. **An economic history of europe 1760-1939**. Strand: Methuen, 1962.

BRAMLEY, G. Land-use planning and the housing market in britain. **Environment & Planning** A, 25, p. 1021-1051, 1993.

BROUWER, R.; SLANGEN, L. H. G. Contingent valuation of the public benefits of agricultural wildlife management: the case of Dutch peat meadow land. **European Review of Agricultural Economics**, vol. 25, n. 1, p. 53-72, 1998.

BRUNSTAD, R. J.; GAASLAND, I.; VARDAL, E. Agricultural production and the optimal level of landscape preservation. **Land Economics**, v. 75, n. 4, p. 538-46, 1999.

BRYDEN, J. M. **Towards sustainable rural community**. Research Report. Guelph: University of Guelph, 1994.

BULLER, H. The agri-environmental measure 2078/92. In: BROUWER, F. M.; LOWE, P. (Eds.). **CAP regimes and the European Countryside**. Wallingford: Cabi Publishing, 2000, p. 199-219.

CLEVELAND, C. J. Re-allocating work between human and natural capital in agriculture: examples from India and the United States. In: JANSSON, A.; HAMMER, M.; FOLKE, C.; COSTANZA, R. (Eds.). **Investing in natural capital**. Washington, D.C.: Island Press, 1994.

COASE, R. H. The problem of social cost. **Journal of Law and Economics**, v. 3, p. 1-44, 1960.

CONWAY, G. R. The properties of agrosystems. **Agricultural Systems**, v. 24, n. 2, p. 95-117, 1987.

DEBLITZ, C. Vergleichende Analyse der Ausgestaltung und Inanspruchnahme der Umweltprogramme zur Umsetzung der VO(EXG) 2078/92 in ausgewählten Mitgliedstaaten der EU. Sonderheft 195, Landbauforschung Völkenrode, Braunschweig, 1999.

DRAKE, L. The non-market value of Swedish agricultural landscape. **European Review of Agricultural Economics**, v. 19, n. 3, p. 351-64, 1992.

FAO. Online statistical database. FAO <http://apps.fao.org> (25-03-2002).

FINCO, A.; NIJKAMP, P. Sustainable land use: methodology and application. In: LONERGAN, S. (Ed.). **Environmental change, adaptation and security**. New York: Kluwer Academic, 1999. p. 88-97.

FLEISCHER, A.; TSUR, Y. Measuring the recreational value of agricultural landscape. **European Review of Agricultural Economics**, v. 27, n. 3, p. 385-98, 2000.

FRESCO, L. O. Imaginable futures: a contribution to thinking about land use planning. In: FRESCO, L. O.; STROOSNIJDER, L. BOUMA, J.; van KEULEN, H. (Eds.). **The future of the land.** Chichester: John Wiley, 1994, p. 1-8.

FURUSETH, O. J. Public attitudes toward local farmland protection programs. **Growth and Change**, v. 18, n. 3, p. 49-61, 1987.

GARDNER, B. D. The economics of agricultural land preservation. **American Journal of Agricultural Economics**, v. 59, n. 5, p. 1027-36, 1977.

HANLEY, N.; KIRKPATRICK, H.; SIMPSON, I.; OGLETHORPE, D. R. Principles for the provision of public goods from agriculture: modeling moorland conservation in Scotland. **Land Economics**, v. 74, n. 1, p. 102-13, 1998.

HANSEN, J. W. Is agricultural sustainability a useful concept? **Agricultural Systems**, v. 50, n. 2, p. 117-43, 1996.

HILL, S. B.; MacRAE, R. J. Developing sustainable agricultural education in Canada. **Agriculture and Human Values**, v. 5, n. 4, p. 92-95, 1988.

JUST, R. E.; MIRANOWSKI, J. A. Understanding Farmland Price Changes. **American Journal of Agricultural Economics**, v. 75, p. 156-168, 1993.

KAY, A. **The reform of the common agricultural policy**. Oxon: CABI Publishing, 1998.

KLINE, J.; WICHELNS, D. Measuring public preferences for the environmental amenities provided by farmland. **European Review of Agricultural Economics**, v. 23, n. 4, p. 421-36, 1996.

KOOTEN, G. C. van **Land resource economics and sustainable development.** Vancouver: UBC Press, 1993.

LEI. **Landbouw-Economisch Bericht**. Den Haag, 2002.

LINDBLOM, C. E.; Woodhouse, E. J. **The policy-making process**. Englewood Cliffs: Prentice Hall, 1993.

MAHÉ, L. P.; ORTALO-MAGNÉ, F. Five proposals for a european model of the countryside. **Economic Policy:** a European forum, v. 28, p. 87-126, 1999.

MUTH, R. The derived demand for urban residential land. **Urban Studies**, n. 8, p. 243-254, 1971.

OECD. **Agriculture and the Environment**. Paris: OECD, 1998a.

OECD. **Environmental indicators for agriculture.** Vol. 1: concepts and framework. Paris: OECD, 1999.

OECD. **Agricultural Policies in OECD Countries**. Paris: OECD, 2001a.

OSTROM, E. **Governing the commons**. Cambridge: Cambridge University Press, 1990.

OWENS, S.; COWELL, R. **Land and limits**. London: Routledge, 2001.

PANNELL, D. J.; GLENN, N. A. A framework for the economic evaluation and selection of sustainability indicators in agriculture. **Ecological Economics**, v. 33, n. 1, p. 135-49, 2000.

PEARCE, D. Measuring sustainable development: implications for agri-environmental indicators. In: OECD (Ed.). **Environmental indicators for agriculture.** Vol. 2: Issues and design. Paris, p. 29-45, 1999.

PEARCE, D.; ATKINSON, G. Measuring sustainable development. In: BROMLEY, D. W. (Ed.). **Handbook of Environmental Economics**. Oxford: Blackwell, p. 166-81, 1995.

PEARCE, D.; TURNER, K. **Economics of natural resources and the environment**. New York: Harvester & Weatsheaf, 1990.

PELT, M. J. F. van **Ecological sustainability and project appraisal**. Avebury: Aldershot, 1993.

PERMAN, R.; MA, Y.; McGILVRAY, J. **Natural resource and environmental economics**. London: Longman, 1996.

PEZZEY, J. **Economic analysis of sustainable growth and sustainable development**. Washington D.C.: The World Bank, 1989

PRUCKNER, G. J. Agricultural landscape cultivation in Austria: an application of the CVM. **European Review of Agricultural Economics**, v. 22, n. 2, p. 173-90, 1995.

PRYCE, G. Construction elasticities and land availability. **Urban Studies** p. 243-254, 1971.

RABBINGE, R.; DIEPEN, C. A. Van; DIJSSELBLOEM, J. DE KONING, G. H. J.; LATESTIJN, H. C. Van; WOLTJER, E.; ZIJL, J. van. Ground for choices: a scenario study on perspectives for rural areas in the European Community. In: FRESCO, L.O.; STROOSNIJDER, L.; BOUMA, J.; KEULEN, H. van (Eds.). **The future of the land**. Chichester: John Wiley, 1994, p. 95-121.

RANDALL, A.; CASTLE, E. N. Land resources and land markets. In: KNEESE, A.V.; SWEENEY, J.L. (Eds.). **Handbook of natural resource and energy economics**. Amsterdam: North-Holland, p. 571-620, 1985.

REENBERG, A.; BAUDRY, J. Land-use and landscape changes – the challenge of comparative analysis of rural areas in Europe. In: KROENERT, R.; BAUDRY, J.; BOWLER, I. R.; REENBERG, A. (Eds.). **Land-use changes and their environmental impact in rural areas in Europe**. Paris: UNESCO, The Parthenon Publishing Group, p. 23-41, 1999.

REICHELDERFER, K.; RANDALL, A. K. Agricultural resource policy. In: CARLSON, G. A.; ZILBERMAN, D.; MIRANOWSKI, J. A. (Eds.). **Agricultural and environmental resource economics**, New York: Oxford University Press, 1993. p. 441-90.

RIGBY, D.; CÁCERES, D. Organic farming and the sustainability of agricultural systems. **Agricultural Systems**, v. 68, n. 1, p. 21-40, 2001.

RIVM. **Milieucompendium 2001**. Rijksinstituut voor Volksgezondheid en Milieu en Centraal Bureau voor de Statistiek. Kluwer, Alphen aan de Rijn, 2001.

SERAGELDIN, I. **Sustainability and the wealth of nations**. Washington, D.C.: The World Bank, 1996

STEENBLIK, R., MAIER, L.; LEGG, W. Sustainable agriculture. **Sustainable Development**. Paris: OECD, p. 117-27, 1997.

STIGLITZ, J. E. **Economics of the public sector**. New York: W.W. Norton, 1986.

TINBERGEN, J. The theory of the optimum regime. In: TINBERGEN , J. (Ed.). **Selected papers**. Amsterdam: North Holland, 1954. p. 264-304.

TISDELL, C. Conditions for sustainable development: weak and strong. In: DRAGUN, A. K.; TISDELL, C. (Eds.). **Sustainable agriculture and environment**. Cheltenham: Edward Elgar, p. 23-36, 1997.

TOKUNAGA, S. **Landownership and residential land use in urban economics**. Berlin: Springer, 1996.

TREWAVAS, A. Urban myths of organic farming. **Nature**, v. 410, p. 409-10, 2001

TURNER, R. K.; OPSCHOOR, J. B. Environmental economics and environmental policy instruments: introduction and overview. In: OPSCHOOR, J. B.; TURNER, R. K. (Eds.). **Economic incentives and environmental policies: principles and practice**. Dordrecht: Kluwer Academic Publishers, p. 1-38, 1994.

VERBRUGGEN, H. Environmental policy failure and environmental policy levels. In: OPSCHOOR, J. B.; TURNER, R. K. (Eds.). **Economic incentives and environmental policies: principles and practice**. Dordrecht: Kluwer Academic Publishers, p. 41-54, 1994.

VERBRUGGEN, H.; JANSEN, H.M.A. International coordination of environmental policies. In: FOLMER, H.; GABEL, H.L.; OPSCHOOR, J. B. (Eds.). **Principles of environmental and resource economics:** a guide for students and decision-makers. Aldershot: Edward Elgar, p. 228-52, 1995.

VERBRUGGEN, H.; KUIK, O. WTO Ministerial conference in Singapore: environmental diversity versus harmonisation. **Environmental and Resource Economics**, v. 10, p. 405-413, 1997.

WCED. **Our common future**. New York: United Nations, 1987.

WEERSINK, A., CLARK, S.; TURVEY, C. G.; SARKER, R. The effect of agricultural policy & farmland values. **Land Economics**, v.75, p. 425-439, 1999.

WILLIS, K.G.; GARROD, G. D. Valuing landscape: a contingent valuation approach. **Journal of Environmental Management**, v. 37, n. 1, p. 1-22, 1993.

ZILBERMAN, D.; MARRA, M. Agricultural externalities. In: CARLSON, G. A.; ZILBERMAN, D.; MIRANOWSKI, J. (Eds.). **Agricultural and environmental resource economics**. New York: Oxford University Press, p. 221-67, 1993.